



US005333209A

United States Patent [19]

Sinden et al.

[11] **Patent Number:** 5,333,209[45] **Date of Patent:** Jul. 26, 1994[54] **METHOD OF RECOGNIZING
HANDWRITTEN SYMBOLS**[75] **Inventors:** Frank W. Sinden, Princeton; Gordon
T. Wilfong, Gillette, both of N.J.[73] **Assignee:** AT&T Bell Laboratories, Murray
Hill, N.J.[21] **Appl. No.:** 857,198[22] **Filed:** Mar. 24, 1992[51] **Int. Cl.⁵** G06K 9/22[52] **U.S. Cl.** 382/13; 382/59[58] **Field of Search** 382/13, 3, 59[56] **References Cited****U.S. PATENT DOCUMENTS**

4,672,677	6/1987	Yamakawa	382/13
5,022,086	6/1991	Crane et al.	382/2
5,023,918	6/1991	Lipscomb	382/24
5,038,382	8/1991	Lipscomb	382/13

OTHER PUBLICATIONS

Tappert, "Cursive Script Recognition by Elastic Matching" *IBM J. Res. Develop.*, vol. 26, No. 6 Nov. 1982 pp. 765-771.

K. Odaka and H. Arakawa, "On-Line Recognition of Handwritten Characters by Approximating Each Stroke with Several Points," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. SMC-12, No. 6, Nov./Dec. 1982.

C. C. Tappert, C. Y. Suen, and T. Wakahara, "The State of the Art in On-Line Handwriting Recognition,"

IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 12, No. 8, Aug. 1990.

K. Zikan, "Least-Squares Image Registration," *ORSA Journal on Computing*, vol. 3, No. 2, Spring 1991.

Primary Examiner—Leo H. Boudreau

Attorney, Agent, or Firm—Geoffrey D. Green

[57] **ABSTRACT**

An unknown handwritten symbol written on a digitizing tablet is compared with symbols in a predefined "alphabet" or library of model symbols and the closest match chosen. Recognition is independent of the size, position or orientation of the symbols. The alphabet can be any collection of symbols, such as alphanumeric characters, ideograms or words in cursive script and is created by writing at least one example of each symbol on the tablet. A sequence of samples of the pen position is recorded while a symbol is being written. The samples form a vector, which is then translated so that the centroid of the symbol lies at an origin. The comparison, which can easily be done in real time, involves calculating a correlation factor from scalar products of the vector for the unknown symbol and two versions of the vector for each model symbol and choosing the model symbol having the highest correlation factor. If needed to distinguish between model symbols with similar correlation factors, the comparison can also include calculating a rotation factor from such vectors for use in making such choice. Embodiments of the invention can be configured that are user-independent, user-dependent or that evolve from one to the other.

36 Claims, 4 Drawing Sheets

